TEERM Overview

Risk Mitigation and Opportunities through Partnerships

Green Engineering Masters Forum

September 30 – October 2, 2009

Presenter: Charles Griffin, TEERM Manager

Agenda

- NASA TEERM Principal Center Overview
  - Mission & History
  - Project Process
  - Projects
  - Partners
  - Value & Successes
  - Summary

TEERM Mission & History

TEERM Mission & History

- NASA KSC is the Principal Center for TEERM.
  - NASA Headquarters established TEERM (formerly the NASA Acquisition Pollution Prevention (AP2) Program Office) in 1998 to help NASA Programs and Centers identify and validate environmental technologies through joint activities that enhance mission readiness and reduce risk while minimizing duplication and associated costs.
  - NASA AP2 was a spin-off of the DoD's Joint Group on Pollution Prevention (JG-PP) (chartered by the Joint Logistics Commanders in 1994)
    - JG-PP formed to address DoD's concern that services (especially OEMs) were duplicating efforts when it came to qualifying new, environmentally preferable materials or processes.

TEERM Mission & History

- In 2007, AP2 changed to TEERM –- Technology Evaluation for Environmental Risk Mitigation –- to highlight new focus:
  - TEERM role in ***evaluating technologies***
  - TEERM role in mitigating ***environmentally-driven risk to mission***. By reducing risk to mission, TEERM is also helping NASA reduce risks to the environment.
    - Hexavalent chromium → Surface coatings → Compliance costs increasing
    - Lead → Electronic soldering and surface finishes → COTS parts going lead-free, but lead-free reliability questionable
    - Isocyanates → Components of coatings on launch pads and ground support → Use is banned or restricted by NASA Centers

Project Process

TEERM Project Process

- Key elements of TEERM's approach
  - Lead NASA efforts to identify and test environmentally preferable alternative materials and processes
    - Identify materials/processes
    - Manage joint testing ("dem/val") projects
    - Advocate for funding for testing
  - Prepare reports and disseminate test results
  - Follow through to next logical step:
    - If validated, advocate for technology implementation
    - If questions remain, further dem/val
    - If no viable alternatives, go back to R&D

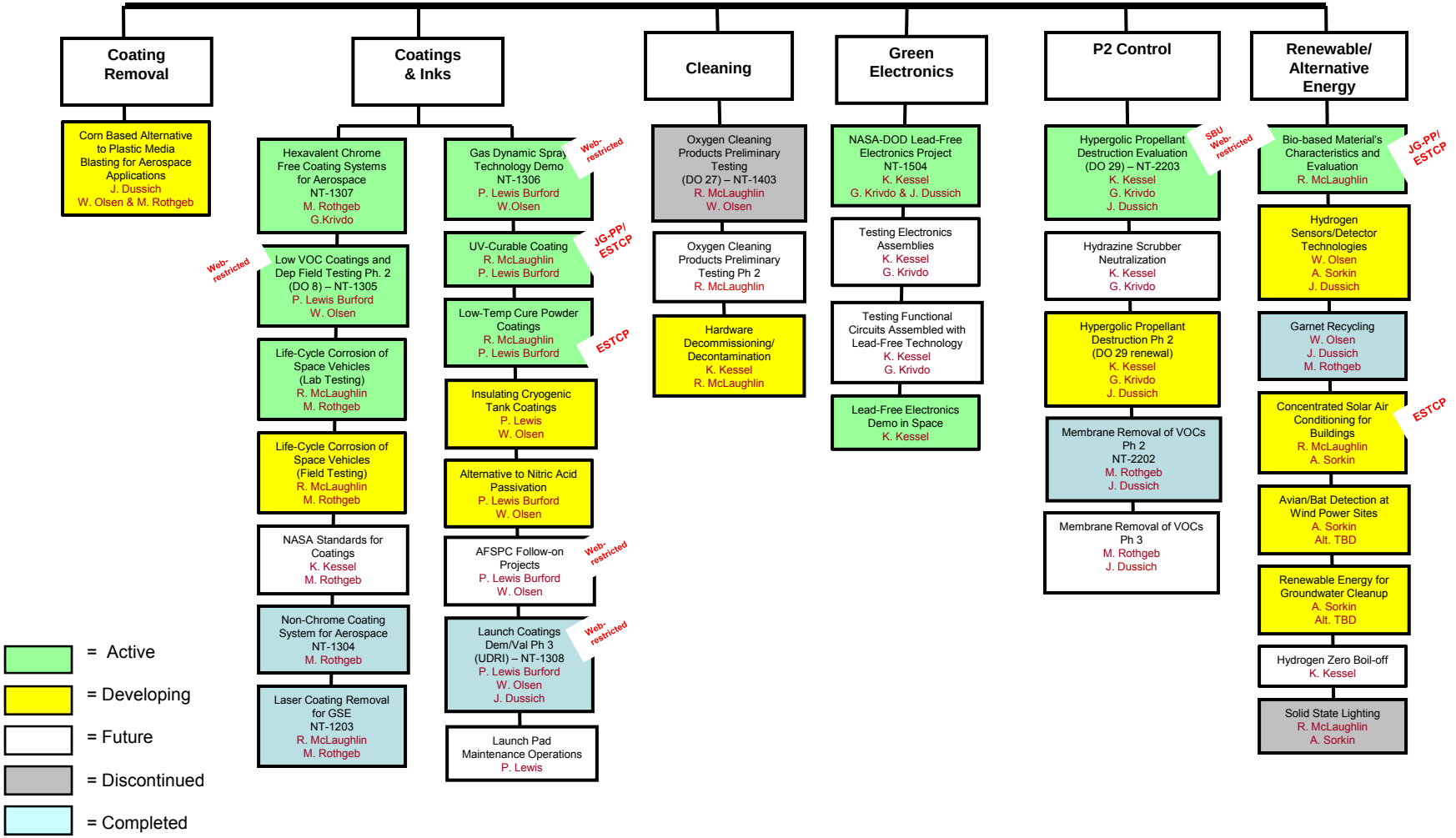
Partnering

TEERM Partnering

- Examples of TEERM project partners:
  - Affected NASA space system program managers and maintenance process owners
  - Industry contractors (domestic or international)
  - Interested Army, Navy, Marine Corps, and Air Force defense system program managers and maintenance process owners
  - Defense Logistics Agency (DLA).
- A key requirement for TEERM to start a project is commitment from two or more entities to participate, with one party being NASA or NASA contractor.

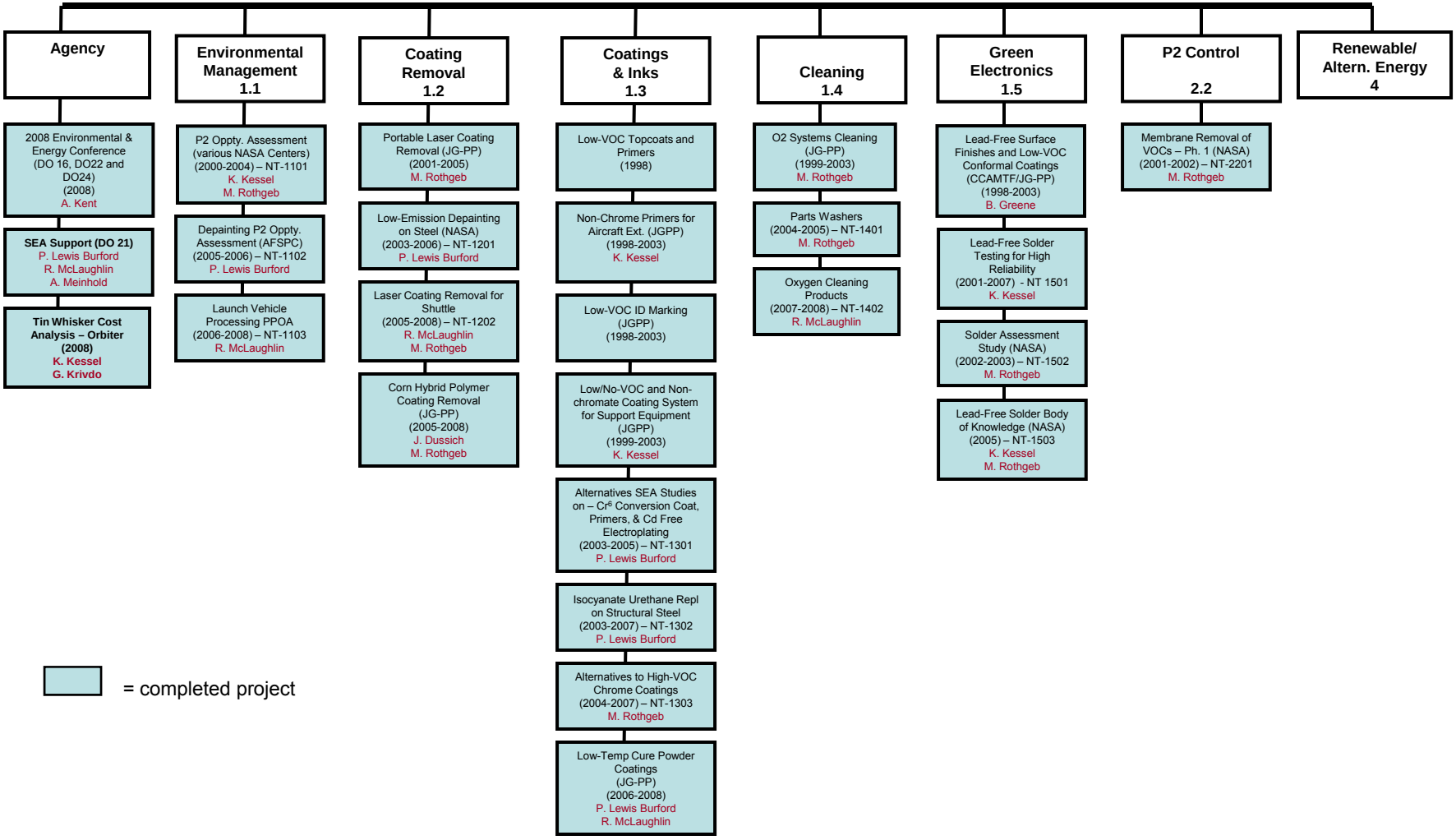
Projects

TEERM Work Breakdown Structure
Demonstration/Evaluation Projects



Info on active and completed projects are available on the TEERM website, www.teerm.nasa.gov

TEERM Completed Projects



TEERM Project
NASA-DOD Lead Free Electronics Project
NT-1504

Status: Active

Description:

- Suppliers of electronics are increasingly moving to non-leaded parts, creating the potential for accidental introduction of lead-free solder onto an assembly, especially during rework. There is a need to better understand and quantify the risks this poses when such assemblies are exposed to harsh military and aerospace environmental conditions.
- For proper mitigation plans to be developed, NASA and DOD need to understand under what conditions electronics reworked with lead-free alloys behave differently conventional tin-lead solder joints
- Project objective is to assess the reliability of solder interconnects applied and reworked with lead-free alloys and with mixed (lead/lead-free) alloys.

Stakeholders:

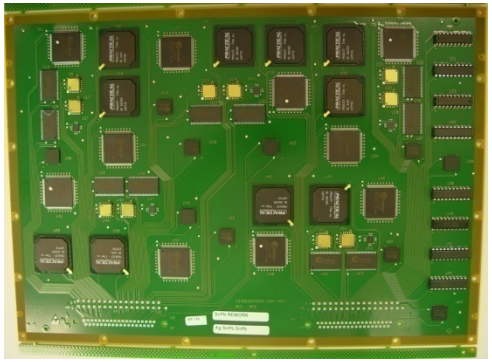
- Work Partners: Boeing, Rockwell Collins, Premier, BAE Systems, Raytheon, NAVSEA, Lockheed Martin, Scorpio, Com DEV, Celestica, PWB
- Other: NASA (Marshall Space Flight Center, JPL, GSFC), DMEA, Air Force, Army

Alternatives:

- Pb-free solder alloys: tin-silver-copper (SnAgCu) & tin-copper-nickel (SnCuNi)
- Pb-free surfaces finishes: Immersion silver and electroless nickel immersion gold

Project Approach:

- Build printed wiring boards containing several types of older and newer electronic component types and soldered using Pb and Pb-free alloys
- Remove and replace some of the components using Pb-free solder (=mixed solder alloy joint)
- Subject boards to various accelerated life tests in the lab and monitor continuously for failures



NASA-DoD LFE Project test vehicle. Assembled by BAE Systems; Irving, Texas

Progress: In testing

Period of Performance: November 2006 to September 2010

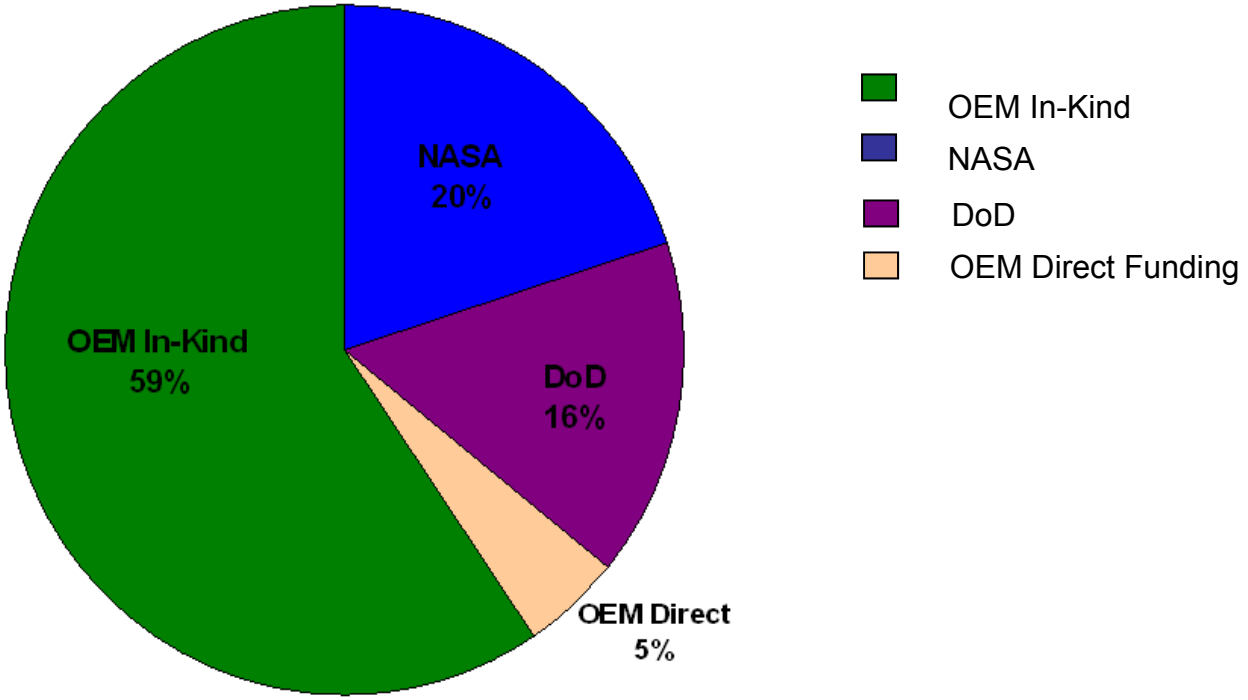
Contact:

- Project Manager: Kurt Kessel, ITB, 321-867-8480, kurt.r.kessel@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web: http://www.teerm.nasa.gov/projects/NASA_DODLeadFreeElectronics_Proj2.html

Value & Successes or TEERM Lead-Free Solder Projects

Team Member Contributions to NASA-DoD Lead-Free Electronics Projects

5:1 Leveraging of NASA's investment



Conclusion: Sharing of resources reduces cost to test and qualify alternatives

Value & Success of TEERM Lead-Free Solder Projects

- Project involved dozens of leading experts from domestic and international defense contractors who have conducted solder testing in the past
- Project's JTP is recognized as a world-wide guidance for conducting lead-free solder testing
  - » The TEERM project won the international Soldertec award for team excellence in lead-free electronics.
- Data from the 1st project is being used by:
  - researchers in their mathematical models to predict lead-free reliability
  - authors of specifications and other electronics industry standards
- Project is referenced in FAA's air worthiness advisory

Conclusion: Improves the technical quality of the effort through knowledge sharing

TEERM Project
Evaluation of Corn Based Alternative to Plastic Blasting Media for Aerospace

Status: Developing

Description:

- Corn Hybrid Polymer (CHP) : bio-based, cost effective, “drop-in” replacement to plastic media blasting (PMB) which meets current specifications (MIL-P-85891) and USDA BioPreferred Program federal procurement requirements.
- Potential cost savings due to characteristics which allow for post-blasting process elimination, longer product life cycle, less frequent booth filter change-outs, less risk of costly substrate damage, not directly tied to petroleum prices, etc.
- Potential environmental benefits: current technology uses non renewable petroleum based or formaldehyde based chemicals. CHP is 100% organic , biodegradable, U.S. product.
- Potential Non Destructive Evaluation (NDE) process improvement., CHP is low dust, UV detectable and will not liquefy and seal hairline cracks resulting in visual inspection improvement.
- Project objective is to validate CHP as a bio based “drop in” alternative for Solid Rocket Booster (SRB) refurbishment processes, and to assist in implementation.
- Customer specifications include qualification against current NASA requirements (i.e.: MIL-P-85891)

Stakeholders (Proposed):

- Work Partners: NASA (Kennedy Space Center), ATK Launch Systems (ATK), United Space Alliance (USA), Archer Daniels Midland (ADM), Midvale Technologies, Institutional Services Contract (EG&G)

Alternatives:

- Corn based blast media

Project Approach:

- Process understanding of all SRB refurbishment activities involving targeted de-coating processes at Kennedy Space Center & ATK Launch Systems Clearfield Refurbishment Center
- Finalization of all project stakeholders & team members
- Validation of CHP as a “drop in” replacement for NASA processes
- Research into potential inspection process improvement
- Research into potential post blast wipe-down process elimination or minimization
- Implementation at NASA centers.

FIG 4 DEFLECTION WITH ENVIROSTRIP FIG.5 DEFLECTION WITH PLASTIC MEDIA

Progress: Planning project

Contact:

- Project Manager: Jahn Dussich, ITB, 321-867-8480, jahn.m.dussich@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

Value & Success of Corn Based Alternative to Plastic Blasting Media Project

- Original JG-PP project (Lead: Navy)
  - >$400K, multi-service DOD effort
  - Validated corn hybrid polymer (CHP) based blasting for numerous DOD and Coast Guard applications;
  - CHP now installed at DOD bases
- As follow-on to JG-PP, TEERM orchestrated two demonstrations of CHP at NASA KSC.
- Existing DOD experience can enable getting CHP approved for NASA implementation.
  - Similar substrates evaluated
  - Tested to similar performance requirements

Conclusion: Enhanced technical confidence in alternatives to be tested

TEERM Project
Hex-Chrome Free Coating Systems for Aerospace Applications (Phase 2)
NT-1504

Status: Active

Description:

- There is a need for coating systems that provide the necessary protection from degradation but which promote less environmental and worker safety risk. Presently one of the biggest risks of many coatings is their incorporation of hexavalent chromium.
- Hexavalent chromium-free coating systems have potential applications for NASA aircraft and aerospace vehicles. There is common interest from DoD components and defense and space prime contractors.
- Coating systems that contain hexavalent chromium in just the pretreatment or the primer reduce chromium exposure but do not eliminate it.
- Project objective is to evaluate and test coating systems that do not contain hexavalent chromium as replacements for aerospace applications.

Stakeholders:

- Work Partners: Kennedy Space Center, Marshall Space Flight Center, Hill Air Force Base. Spirit Aerosystems,
- Other: NASA (Johnson Space Center, MAF), Constellation Program – Ares Upper Stage, Johnson Space Center Orion, Air Force, Boeing, Lockheed Martin, Raytheon, United Space Alliance

Alternatives:

- Pretreatments (4): PreKote, Alodine 5200, METALAST TCP-HF, VpCI-440
- Primers (10): Akzo Nobel Aerospace Coatings / Mg Rich, Sicopoxy 577, Deft 084, Deft 098
- Top Coat: MIL-PRF-85285B Type 1, Class H

Project Approach:

- Select alternatives for testing based on prior work (NASA TEERM and others)
- Apply coatings to test panels and place near an active launch complex and at beach test site
- Evaluate coatings regularly during the 18 months
- Evaluate non-chrome coatings for electronic housings (bare corrosion resistance and electrical impedance)

Hex-chrome free coating systems in field testing

Progress: In testing

Period of Performance: August 2008 to August 2010

Contact:

- Project Manager: Matt Rothgeb, ITB, 321-867-8476, matthew.j.rothgeb@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web: http://teerm.nasa.gov/projects/NonChromeCoatingSysForAerospace.html

Value & Success of TEERM Hex-Chrome Free Coating System Project

- TEERM-led project involving multiple organizations within NASA and DOD
- Coordinated effort with NASA and DOD groups so as not to unnecessarily duplicate efforts and so that TEERM results valuable to Orion, Ares and DOD.
  - Various parties contributing to Joint Test Protocol
  - Air Force and Ares Upper Stage are donating materials and coatings
  - MSFC doing in-kind lab testing

Conclusion: Avoids duplication of effort among parties

Low VOC Coatings and Depainting Field Testing Phase 2
NT-1305

Status: Active

Description:

- Need: Eliminates risks associated with environmental, safety, and health concerns of VOCs from coatings and particulate emissions from depainting operations from maintenance.
- Value to NASA: Less required maintenance results in fewer environmental considerations and increased mission readiness due to quicker turn-around times.
- Operational Gap: PM and VOC emissions are restricted by various environmental and safety regulations.
- Project Description: Project objective is to test and qualify depainting and coating alternatives for maintenance operations at Air Force Space Command (AFSPC) and NASA launch structures.
- Focus is on surface preparation/depainting, ambient condition corrosion protection (on the Mobile Support Tower or MST) and moderate heat (400-600 deg F) and launch exhaust resistance (on the Fixed Umbilical Tower or FUT).
- Although Thermal Spray Coatings (TSCs) are approved for use, their ability to withstand launch conditions is not well known. This project will provide important data about the survivability of TSCs.

Stakeholders:

- Work Partners: NASA Corrosion Technology Laboratory, US Technology Corp., Thermion
- Other: Kennedy Space Center, AF 45th Space Wing and HQ Air Force Space Command.

Alternatives:

- Coatings: 2 thermal spray (Zn and Al-Mg), 1 ablative(GE silicone), 3 liquid (low-VOC) coating systems, and 1 topcoat for the thermal sprays.
- Depainting: Abrasive blasting equipment w/ 2 hard abrasives

Project Approach:

- Select alternatives for field testing based on prior work
- Apply and demonstrate coatings on active launch complex
- Evaluate coatings on the FUT after each launch
- Evaluate coatings on the MST every 6 months over 18 months

Progress: Post testing

Period of Performance: October 2006 to September 2009

Contact:

- Project Manager: Pattie Lewis Burford, ITB, 321-867-9163, pattie.l.lewis@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

Launch Coatings Phase 3
NT-1308

Status: Completed

Description:

- Need: Eliminates risks associated with environmental, safety, and health concerns of VOCs from coatings and particulate emissions from depainting operations from maintenance.
- Value to NASA: Less required maintenance results in fewer environmental considerations and increased mission readiness due to quicker turn-around times.
- Operational Gap: PM and VOC emissions are restricted by various environmental and safety regulations.
- Project Description: Project objective is to test and qualify depainting and coating alternatives for maintenance operations at Air Force Space Command and NASA launch structures.
- The focus of the project is heat resistant coatings that can withstand multiple launches while providing adequate corrosion protection in between resulting in less required maintenance.
- The goal is to reduce the amount of maintenance required to maintain the performance of launch structures.

Stakeholders:

- Work Partners: NASA Corrosion Technology Laboratory, AF 45th Space Wing, Air Force Research Laboratory/University of Dayton Research Institute.
- Other: Kennedy Space Center, HQ Air Force Space Command

Alternatives:

- Coatings: 3 heat resistant (failed after TSFay), 2 thermal spray (Zn & Al), GE ablative, gas dynamic spray (Zn & ZnAl)
- Depainting: Abrasive blasting equipment w/ 2 hard abrasives

Project Approach:

- Select alternatives for field testing based on prior work
- Application and field demonstration of coatings on active launch complex
- Evaluate coatings on the FUT blast shields after launch
- Demonstrate surface preparation equipment

Application of Thermal Spray Coating to Heat Shield

Progress: Post testing

Period of Performance: March-2008 to June-2009

Contact:

- Project Manager: Pattie Lewis Burford, ITB, 321-867-9163, pattie.l.lewis@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

Value & Success of NASA-Air Force Coatings Projects

- Ground Support Equipment and Ambient Temperature Applications
  - Low-VOC and chromium/isocyanate-free coating products on the Qualified Product List (QPL) are used by NASA and Air Force for GSE (e.g., antennae, radar dishes), and non-launch exposure zones of launch structures.
  - After extensive lab and beach testing by TEERM-AFSPC, five low-VOC and chromium/isocyanate-free coating products were qualified and added to QPL.
  - NASA and Air Force are looking to expand applications of environmentally friendly coatings that provide adequate corrosion protection.
- High Temperature Applications
  - Few coatings are suitable for use in applications where exposure to launch conditions (heat and exhaust products) occurs.
  - Current TEERM-AFSPC projects are evaluating QPL and non-QPL coatings under actual launch exposure conditions at CCAFS.
    - If successful, look to expand testing/implementation to Vandenberg AFB.

Conclusion: TEERM is accelerating implementation of qualified alternatives

TEERM Future Direction

- New Efforts and Possibilities
  - Efforts of lower technology readiness (TRL <5). Examples:
    - Hydrazine neutralization w/ AKGA [b]
    - Microwave destruction of hypergol wastes [a]
    - Green chemistry for oxygen system cleaning [a]
  - Efforts at reducing petroleum dependency
    - Renewable energy coupled with groundwater cleanup (WSTF) [b]
    - Biobased materials characteristics and evaluation (w/ JG-PP) [a]
    - Hydrogen sensors/detector technologies (for fuel cell sites, etc.) [a]
    - Concentrated solar air conditioning for buildings (w/ DOD) [b]

[a] preliminary/pilot TEERM project underway

[b] at proposal/ project development stage

TEERM Summary

- TEERM is proactive – sometimes ahead of regulations
- TEERM's evaluation of technologies is unbiased
- Stakeholder participation in TEERM dem/val projects is strongly encouraged, but amount can be voluntary.
- Government/industry partnerships are key to TEERM and NASA success.
- Implementation of TEERM-validated alternatives reduces NASA's exposure to institutional, programmatic and operational risks.

For more information visit the NASA TEERM Website:

www.teerm.nasa.gov/

or contact:

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Back Up

Gas Dynamic Spray Technology Demonstration
NT-1306

Status: Active

Description:

- Need: Gas Dynamic Spray Coatings contain no VOCs; the unit is self-contained including surface preparation and coating application equipment that can be used for spot repair/maintenance of metallic substrates including Thermal Spray Coatings.
- Value to NASA: Gas Dynamic Spray technology could repair substrates that could otherwise require replacement or be used as a repair for Thermal Spray Coatings (also 0 VOC and approved in NASA-STD-5008.
- Operational Gap: PM and VOC emissions are restricted by various environmental and safety regulations.
- Project Description: Gas Dynamic Spray (also known as Cold Spray) is similar to Thermal Spray Coatings (TSCs), but uses kinetic energy rather than heat to promote adhesion to the substrate.
- The unit is self contained and can be used for surface preparation and coating application with the simple flip of a switch.
- Focus is the repair of metalized thermal spray coatings, especially on corners.

Stakeholders:

- Work Partners: NASA Corrosion Technology Laboratory, AF 45th Space Wing
- Other: Kennedy Space Center, and Air Force Space Command.

Alternatives:

- Zinc powder w/ gas dynamic spray (funded)
- ZnAl, pure Al (unfunded)

Project Approach:

- Select coating alloys
- Coat panels
  - Thermal spray coat, then damage & repair w/ GDS
  - Coat difficult-geometry panels w/ thermal spray & then coat corners/edges w/ GDS
  - Topcoat 1 and 2
  - Un-top coated 1 and 2
- Place at beach test site for 18 months

Portable Gas Dynamic Spray Unit

Progress: Preparing for testing

Period of Performance: August 2007 to December 2010

Contact:

- Project Manager: Pattie Lewis Burford, ITB, 321-867-9163, pattie.l.lewis@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Cryogenic Tank Coatings

Status: Developing

Description:

- Need: The current coating system has high VOC levels and requires extensive maintenance due to its inability to prevent corrosion and fungal growth.
- Value to NASA: Qualifying a low VOC alternative will improve protection of the structure, reducing required maintenance that results in VOC emissions from coatings and particulate emissions from depainting operations. An improved alternative can also prevent excessive boil-off of tank contents resulting in significant cost saving thus improving mission readiness.
- Operational Gap: Current system does not provide corrosion and fungal growth protection while VOC emissions are restricted by various environmental and safety regulations.
- Project Description: A 50-year oldLH2 tank at Kennedy Space Center is having issues with corrosion, fungal growth, and excessive boil-off.
- The proposed project would demonstrate/ validate low VOC coatings that provide thermal insulation, corrosion protection, and fungal resistance.

Stakeholders (Proposed):

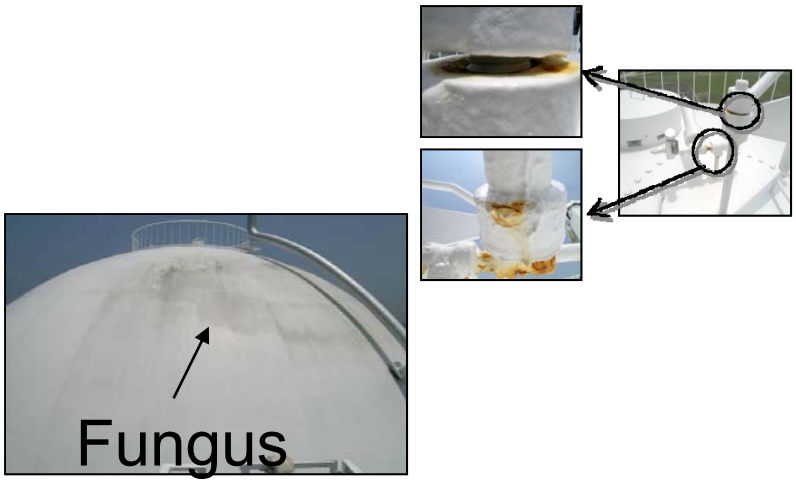
- Work Partners: Kennedy Space Center Cryogenics Lab, NASA Corrosion Technology Laboratory
- Other: Stennis Space Center, Marshall SFC, Langley Research Center, White Sands Testing Facility, Vandenberg AFB, European Space Agency

Alternatives:

- To be determined

Project Approach:

- Achieve stakeholder buy-in
- Identify alternatives
- Determine testing requirements
- Support development of “proposal” for funding to test & qualify coating/s



Cryogenic tanks

Progress: Defining requirements

Contact:

- Project Manager: Pattie Lewis Burford, ITB, 321-867-9163, pattie.l.lewisl@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Citric Acid Passivation Study Project

Status: Developing

Description:

- Need: Nitric acid is currently used to passivate stainless steel resulting in a large amount of hazardous waste and Nitrogen Oxide (NOx) emissions.
- Value to NASA: Qualifying citric acid as an alternative will eliminate the use of a hazardous substance and its associated costs and impacts.
- Operational Gap: In addition to free irons, nitric acid can also remove nickel, chromium, or other heavy metals from the surface which are beneficial.
- Project Description: Qualify citric acid as a non-hazardous alternative to nitric acid for passivation of stainless steel.

Stakeholders (Proposed):

- Work Partners: Kennedy Space Center Ground Ops (USA), NASA Corrosion Technology Laboratory
- Other: Air Force, USMC, AFSPC

Alternatives:

- Citric Acid

Project Approach:

- Achieve stakeholder buy-in
- Identify substrates
- Determine testing requirements
- Support development of “proposal” for funding to test & qualify coating/s

Progress: Planning project

Contact:

- Project Manager: Pattie Lewis Burford, ITB, 321-867-9163, pattie.l.lewis@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Testing Functional Circuits Assembled with Lead-Free Technology

Status: Developing,

Description:

- Need: Numerous laboratory studies, past, present and planned, are attempting to better understand how Pb-free will affect the reliability of electronics exposed to the harsh operating conditions of aerospace applications. However, there is a lack of data from functioning electronics containing Pb-free components
- Value to NASA: Data generated from this effort will help current and future programs better understand the risks associated with lead-free technology. Current NASA Policy Directive (NPD 8730.2C) "NASA Parts Policy" only allows the use of lead-free solder and component finishes when "justified by technical need". Data from the NASA-DoD Lead-Free Electronics Project will help program managers determine if lead-free technology is a viable option for spaceflight and critical ground support applications.
- Operational Gap: Lack of data from functioning electronics containing Pb-free components or that have been assembled using only Pb-free components and solder alloys.
- Project Description: To obtain reliability data from functional lead (Pb) free electronic assemblies designed for operation in harsh aerospace environments.

Stakeholders (Proposed):

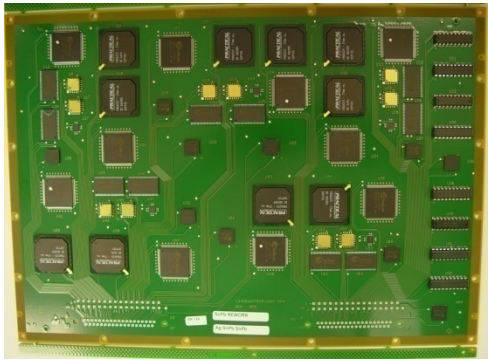
- Work Partners: NASA KSC, MSFC
- Other: DoD, Electronics OEMs

Alternatives:

- Solder Alloys: SnAgCu and SnCuNi
- Surface Finishes: Immersion Ag

Project Approach:

- Build printed wiring boards containing several types of older and newer electronic component types and soldered using Pb and Pb-free alloys
- Remove and replace some of the components using Pb-free solder (=mixed solder alloy joint)
- Subject boards to various real-world environmental conditions on an active test platform and monitor for failures (ideally continuously)



NASA-DoD LFE Project test vehicle

Progress: Planning project

Contact:

- Project Manager: Kurt Kessel, ITB, 321-867-8480, kurt.r.kessel@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Oxygen Cleaning Products Preliminary Testing Year 2
NT-1403

Status: Active

Description:

- Dependence on Ozone Depleting Substance (ODS) usage beyond the production phase-out year 2015 will create potentially increasing risks to NASA mission capability and costs. It is critical to mission capability and the reduction in costs that NASA minimizes these risks.
- Desire an economically and technically feasible alternative for cleaning oxygen systems aboard new NASA space vehicles that does not increase environmental, safety, or occupational health risks and costs. Issues with current chemicals include: flammability, volatility, solvency/cleanability, liquid oxygen compatibility, toxicity, environmental persistence, supplier availability/cost; some alternatives qualified as replacements to Class I and II ODSs also have high greenhouse gas emission equivalency factors and may be subject to future regulation.
- Project leverages Year 1 effort by Yale and explores various classes of alternatives in more detail with the goal of elevating strong performers to validation phase
- Current cleaning materials used include: HCFC-225g (Cl.II ODS), isopropyl alcohol, HFE 7100, Vertrel MCA, trichloroethylene (Cl.I ODS), perchloroethylene, and cyclohexane

Stakeholders:

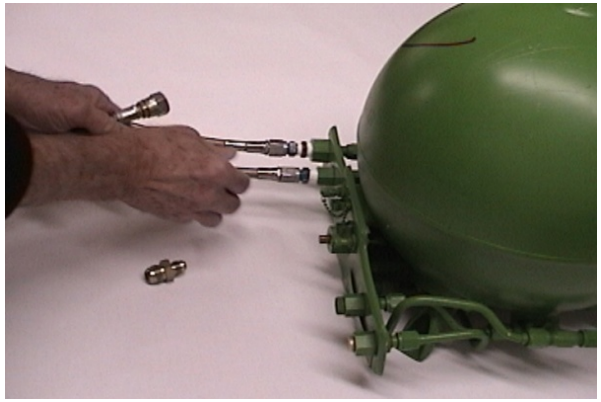
- Work Partners: White Sands Test Facility and Yale University

Alternatives:

- Fluorocarbons
- Surfactants
- Room Temperature Ionic Liquids
- Aqueous solutions
- Supercritical liquids

Project Approach:

- Determine level of fluorination in fluorocarbons necessary to mitigate flammability issues
  - Chain lengths 5 to 7(avoids low boiling point, avoids long persistence, easy distillation, increased feasibility of recycling)
- Complete residue testing of fluorinated/perfluorinated molecules and anionic/nonionic surfactants
- Complete modeling of hydrophobic ionic liquids



Demonstration of lines which need cleaning

Progress: Post testing

Period of Performance: October 2008 – September 2009

Contact:

- Project Manager: Rusty Mclaughlin, ITB, 321-867-3351, russell.l.mclaughlin@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web:http://teerm.nasa.gov/projects/OxygenCleaningProductsPreliminaryTesting.html

TEERM Project
Concentrated Solar Air Conditioning for Buildings

Status: Developing

Description:

- A need exists within both DoD and NASA for a small-footprint, easily installed solar thermal energy system utilizing proven technology to cost-effectively drive industrial-sized absorption air conditioning systems and provide thermal energy storage to effectively extend the solar day. Reliable access to affordable, stable energy supplies is a significant challenge for DoD and NASA installations. Any disruption of critical power supplies would harm the DoD and NASA's ability to accomplish its missions. Such a risk exposes a vulnerability that must be addressed by a more secure energy position and outlook.
- Potential to significantly increase the efficiency and lower the energy demands for air conditioning. (Summer AC loads account for 30-60% of total energy expenditures at DoD facilities.) Money saved frees up fiscal and personnel resources, and helps agencies meet regulatory requirements (e.g., EO 13423, EPA 2005, EISA 2007).Solar energy can greatly enhance adsorption air conditioning by being renewable as well as offering high temperatures and therefore greater efficiency than traditional waste heat sources. In addition, as a participating demo site, the NASA Center would get to keep the installed MicroCSP unit.
- The project object is to demonstrate that micro Concentrated Solar Power (MicroCSP™) solar collectors can be integrated with absorption chillers to provide a renewable energy based source of air conditioning.

Stakeholders (Proposed):

- Work Partners: Navy (NAVFAC) [Principal Investigator], Sopogy [Turnkey], Trane/ ANS/REC [subcontractors]; Possible demo site: Luke AFB (AZ), Davis-Monthan AFB (AZ), Marine Corps Air Station Yuma (AZ), USMC Camp Pendleton (CA).
- Other: NASA JSC & DFRC, ITB/TEERM

Alternatives:

- MicroCSP (parabolic solar collectors) coupled with absorption chiller. Using a smaller footprint trough technology specifically for air conditioning and process heat applications, as well as smaller power plants from 1MW to 20MW, is a new innovation that would be further explored in this project. The area requirements will be approximately 3,000 sf per 10 tons of cooling for the solar array.

Project Approach:

- Install MicroCSP on an existing adsorption chiller one DOD site
- Demonstrate and monitor units over at least 12 months to:
  - assess electricity savings attributed to renewable energy
  - determine quantities of thermal energy that can be offset with solar thermal plants
  - demonstrate the ability of the system to be rapidly deployed
  - prove that MicroCSPTM is a cost-effective alternative to fossil fuel based energy.
- Volunteer test sites will keep the installed MicroCSP unit.

"Sopogy's MicroCSP™ Solar Collector "SopoNova 4.0™" (Illustration courtesy of Sopogy

Progress: Planning project

Period of Performance (Proposed): October 2009 to February 2013 (~3.5 years)

Contact:

- Project Manager: Rusty McLaughlin, ITB, 321-867-3351, russell.l.mclaughlinl@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Solid State Lighting

Status: Discontinued

Description:

- Need: Energy efficiency and mercury minimization
- Value to NASA: Solid State lighting (SSL) technologies have been shown to use less energy and have a longer life than current technologies; SSL eliminates mercury concerns
- Project objective is to demonstrate/validate commercial solid state lighting alternatives to fluorescent tubes for typical indoor NASA office environments

Stakeholders:

- Work Partners (Proposed): Kennedy Space Center, UCDavis, RPI
- Other (Proposed): NASA Energy Managers, Facilities Division, LED lighting vendors: Cree, Lighting Science Group Corp, Luximo, Digital Lighting, Finelight Inc

Alternatives:

- Likely product applications will consist of general conventional 2' x 4' and task/desk lighting replacements

Project Approach:

- Develop JTP (Draft JTP developed 21Nov08)
- Choose Test locations
- Cost Benefit Analysis
- Distribute findings throughout Energy and Facility Managers

White-light LED

Contact:

- Project Manager: Rusty McLaughlin, ITB, 321-867-3351, russell.l.mclaughlin@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Hydrogen Sensors

Status: Developing

Description:

- The need exists to develop reliable hydrogen safety sensors that can be easily manufactured, inexpensively deployed and provide optimal acceptance by end users. The development of efficient hydrogen production, storage, and utilization technologies brings with it the need to pro-actively detect and pinpoint hydrogen leaks to protect people and equipment.
- The possibility exists to field hydrogen fuel cell emergency generators to replace current petroleum-fueled generators. Hydrogen fuel cells operate cleaner, are more efficient and have better reliability than their petroleum-based counterparts. Providing sensors and detectors for a safer hydrogen power generation system can accelerate project implementation
- Project objective is to evaluate the performance of emerging hydrogen sensor technologies to accelerate deployment of stationary fuel cell installations at NASA facilities while mitigating associated safety risks.

Stakeholders (Proposed):

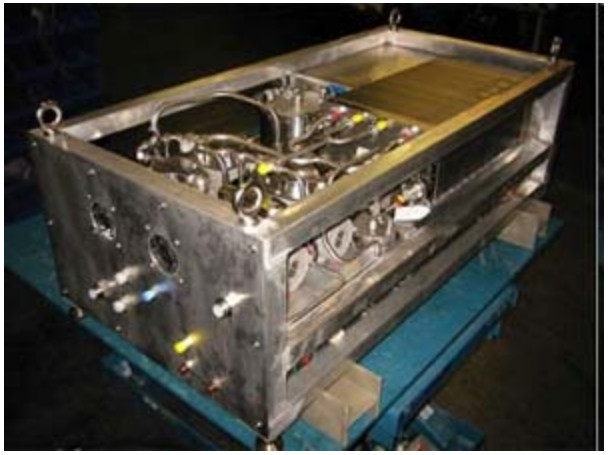
- Work Partners: NREL & NIST (consolidated safety standards) (Lab), WSTF (field testing), Johnson Space Center (Hydrogen Fuel Cell End User).
- Other: NASA Johnson Space Center, Kennedy Space Center, WSTF, GRC; NREL; NIST; DOE, Commercial detector companies

Alternatives:

- At least 9 sensor technology types, many are application specific (placement, temperature, sensitivity, power source, etc.).
- OEMs: H2Scan (sensors + handheld detectors); Makel (smart sensors); NexTech (hydrogen safety sensor); Element One (H2 sensing tape/coating); Etc

Project Approach:

- Identify which if any technologies off shelf are feasible, if none consider SBIR or similar call for proposal.
- Engage key research facilities and labs (NREL, WSTF)
- Determine sensor detection capability under various climatic conditions in the lab.



A phase-one proton exchange membrane fuel cell design for space exploration developed by Teledyne. Credit: NASA

Progress: Planning project

Contact:

- Project Manager: Wade Olsen, ITB, 321-867-8467, wade.l.olsen@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Garnet Recycling

Status: Developing

Description:

- A NASA Center has requested TEERM to identify recycling opportunities for garnet grit waste generated from the abrasive water jet (AWJ) cutting machine process.
- Every AWJ at the NASA Centers are operated and managed independently. As a result, methods for material use/reuse and waste classification/disposal are inconsistent and therefore, may benefit from process improvements to reduce and/or eliminate hazardous wastes.
- Project objective is to identify AWJ processes using garnet grit at NASA centers and provide solutions for waste minimization through material reuse and recycling.

Stakeholders (Proposed):

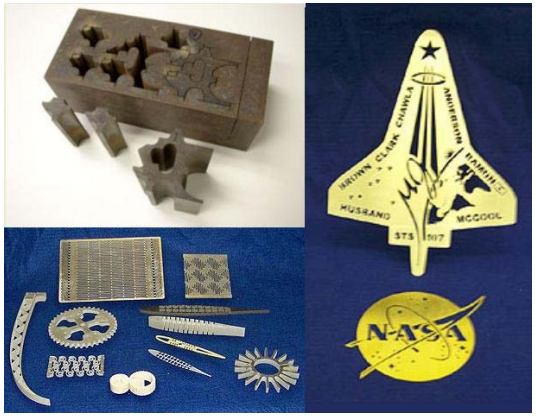
- Work Partners: ARC, GRC, Kennedy Space Center, LaRC, Marshall Space Flight Center, MAF, WFF and other centers utilizing abrasive water jet cutting machines.
- Other: ATK, Utah (Promontory)

Alternatives:

- Status Quo

Project Approach:

- Determine scope of garnet usage
- Evaluate recycling alternatives
- Share information across NASA
- Evaluate branching to DoD



Water Jet cuttings

Progress: Planning project

Contact:

- Project Manager: Wade Olsen, ITB, 321-867-8467, wade.l.olsen@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web: http://www.teerm.nasa.gov/

TEERM Project
Life Cycle Corrosion of Space Vehicles (Lab Testing)

Status: Developing

Description:

- Project objective is to obtain a clear understanding of the lifecycle environment as it pertains to corrosion potential and potential coating repair cycles for space vehicles, beginning with testing at Kennedy Space Center LC-39B.
- Identify and validate of repair techniques for hex-chrome free coatings that are effective in protecting assets and mitigating risk to mission.

Stakeholders (Proposed):

- Work Partners: NASA Kennedy Space Center, Marshall SFC, Air Force, CTIO, UDRI

Alternatives:

- Materials: Best-performing coating products from TEERM Hex-Chrome Free Coatings Project.
- Methods:
  - Accelerated Corrosion / Controlled Environmental Cabinets w/ various weather limits
  - Salt-Fog testing of re-worked non-chrome coatings from lab, beach and launch complex.

Project Approach:

- Initial screening tests will focus on characterizing the environment at this location and attempting to simulate this environment in an accelerated laboratory test.
- Additional testing will be performed on the repair and re-exposure of non-chrome coating systems after exposure and compromise to better understand necessity of maintenance that may be necessary with a fully Hex-Chrome free coating system.
- Later Phases will address in a similar way the other environments that components for CxP and other assets exist in during their lifecycle, from assembly to launch

Progress: Planning project

Contact:

- Project Manager: Matt Rothgeb, ITB, 321-867-8476, matthew.j.rothgeb@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Laser Coating Removal for GSE
NT-1203

Status: Completed

Description:

- Project objective was to determine viability of lasers to replace hand sanding and plastic media blasting for removing various coatings on NASA GSE.

Stakeholders:

- Boeing, USA, and NASA GRC, Kennedy Space Center, Johnson Space Center

Alternatives:

- Portable Laser Coating Removal Systems:
  - Adapt Laser Systems 120 Watt Nd:YAG Laser
  - Adapt Laser Systems 150 Watt Nd:YAG Laser
  - Adapt Laser Systems 300 Watt Nd:YAG Laser
  - Adapt Laser Systems 500+ Watt Nd:YAG Laser

Project Approach:

- Leverage off US Air Force testing & implementations to address NASA-specific needs and garner interest.
- Conduct one or more demonstrations for NASA customers and report findings.

Crack in Weld

Period of Performance: August 2005 to May 2009

Contact:

- Project Manager: Matt Rothgeb, ITB, 321-867-8476, matthew.j.rothgeb@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web:http://teerm.nasa.gov/projects/LaserCoatingRemovalForGSE.html

TEERM Project
Non-Chrome Coating Systems for Aerospace Applications (Phase I)
NT-1304

Status: Completed

Description:

- There is a need for coating systems that provide the necessary protection from degradation but which promote less environmental and worker safety risk. Presently one of the biggest risks of many coatings is their incorporation of hexavalent chromium.
- Hexavalent chromium-free coating systems have potential applications for NASA aircraft and aerospace vehicles. There is common interest from DoD components and defense and space prime contractors.
- Coating systems that contain hexavalent chromium in just the pretreatment or the primer reduce chromium exposure but do not eliminate it.
- Evaluation and testing of non-chromated coating systems as replacements for hexavalent chrome coatings in aircraft and aerospace applications.
- Testing of coating systems to DoD and NASA specifications for corrosion resistance using several test methods and adhesion.

Stakeholders:

- NASA (Kennedy Space Center, Marshall Space Flight Center), Shuttle Elements (Boeing, United Space Alliance) & Air Force (Hill Air Force Base, WPAFB AFRL & MLBT)

Alternatives:

- Pretreatments: Alodine 5700, PreKote, ANAC - M790E, BoeGel AC-131CB
- Primers: Sicopoxy 577-630, MgRich (prelim formulation), Aquasurtec Crosslinker, Hentzen (05510WEP-X), Deft 02-Y-40, Dupont Corlar 13570S, Aviox CF Primer,
- Topcoats: Deft 03-GY-321, AquaSurTec D45-AMS, Aviox Finish 77702

Project Approach:

- Laboratory test coating systems to DoD and NASA specifications for corrosion resistance and adhesion.

Period of Performance: October 2005 to May 2009

Contact:

- Project Manager: Matt Rothgeb, ITB, 321-867-8476, matthew.j.rothgeb@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web: http://teerm.nasa.gov/projects/NonChromeCoatingSysForAerospace.html

TEERM Project
Membrane Removal of VOCs Phase 2
NT-2202

Status: Completed

Description:

- Project objective is to demonstrate the feasibility of a membrane unit for removing VOCs from one or more contaminated process air streams (e.g., remediation, paint booth, solvent cleaning, metal finishing, solvent recycling)
- Technology is near to COTS stage, very new and promising for several types of air contaminants
- Applied Membrane Technologies, Chembrane and New Jersey Institute of Technology have agreed to construct mobile test platform in order to test on a wide spectrum of processes and locations.

Stakeholders:

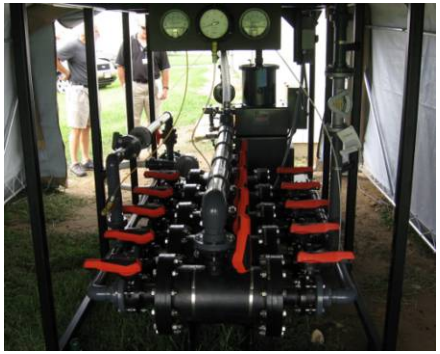
- NJIT, AMT and Chembrane
- Other: NASA Centers (WFF, Kennedy Space Center, Marshall Space Flight Center, GRC, Plumbrook, MAF, WSTF, JPL), NASA Clean Air Act Working Group, and C3P

Alternatives:

- Technology: Silicone-Coated Hollow Fiber Membrane (plasmapolymerized ultra-thin silicone membrane-based vapor permeation process)

Approach:

- Define requirements
- Design and build skid-mounted membrane unit
- Build portable membrane unit
- Demonstrate unit on one or more types of contaminated process air streams (e.g., remediation, paint booth, solvent cleaning, metal finishing, solvent recycling)
- Determined the efficiency of membrane cartridges in numerous orientations and using three mediums (2 oils and air).



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Period of Performance: March 2006 to May 2009

Contact:

- Project Manager: Matt Rothgeb, ITB, 321-867-8476, matthew.j.rothgeb@nasa.gov
- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov
- Web:http://teerm.nasa.gov/projects/MembraneRemovalOfVOCsFromEntrainedAirStreams.html

TEERM Project
Renewable Energy for Efficient Ground Water Cleanup

Status: Developing

Description:

- Pump and Treat groundwater remediation treatment systems at NASA WSTF and JPL are very energy intensive.
- The use of onsite renewable energy coupled with more energy efficient treatment processes can reduce the cost of these long duration NASA cleanup obligations.

Stakeholders:

- Work Partners (Proposed): NASA WSTF
- Other (Proposed): JPL, Aerojet, EPA Green Remediation Initiative, Applied Process Technology Inc.; Sopogy Inc., Deluge Inc..

Alternatives:

- Solar thermal and photovoltaic power sources; thermally driven pumps; energy efficient treatment processes. energy optimized component selection

H_2O

Progress: Planning project

Contact:

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- TEERM Program Manager: Chuck Griffin, NASA, 321-867-6225, chuck.griffin@nasa.gov

TEERM Project
Avian/Bat Detection at Windpower Sites

Status: Developing

Description:

- Project objective is to evaluate bird and bat presence at NASA sites being considered for wind turbine installations so that project permits can be granted for suitable sites
- Determine if emerging detection technologies can be utilized effectively.

Stakeholders:

- (Proposed) NASA WSTF, Wallops, Glenn, Commercial companies with emerging detection technologies (Ex.- DeTect Inc.), U. Mass, USGS, NREL, Army, etc

Alternatives:

- Vertical imaging radar
- Infrared imaging; sonic; etc

Wind Farm

Progress: Planning project

Contact:

- Project Manager: Al Sorkin, ITB, 321-867-8477, alvin.b.sorkin@nasa.gov
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TEERM Value & Successes

- TEERM's approach to project execution helps improve NASA's ability to adopt new material to reduce unacceptable mission risks in a more proactive and cost effective manner. Specifically:
  1. Sharing of resources reduces cost to test and qualify alternatives processes
  2. Enhanced technical confidence in alternatives to be tested
  3. Avoids duplication of effort among parties
  4. Improves the technical quality of the effort through knowledge sharing
  5. Accelerates implementation of qualified alternatives